US009593737B2

(12) **United States Patent**
Colombo et al.

(10) **Patent No.: US 9,593,737 B2**
(45) **Date of Patent: Mar. 14, 2017**

(54) **PRESSURE VALVE FOR GAS SPRING**

(71) Applicant: **GM GLOBAL TECHNOLOGY OPERATIONS LLC**, Detroit, MI (US)

(72) Inventors: **Joel Colombo**, Howell, MI (US); **Michael P. Balogh**, Novi, MI (US)

(73) Assignee: **GM GLOBAL TECHNOLOGY OPERATIONS LLC**, Detroit, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/594,704**

(22) Filed: **Jan. 12, 2015**

(65) **Prior Publication Data**

US 2016/0201754 A1 Jul. 14, 2016

(51) **Int. Cl.**
F16F 9/52 (2006.01)
F16F 9/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F16F 9/526*** (2013.01); ***F16F 9/0281*** (2013.01)

(58) **Field of Classification Search**
CPC F16F 9/02; F16F 9/22; F16F 9/36; F16F 9/52; F16F 9/58; F16F 2230/24
USPC 188/276, 277, 279; 267/120
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,995,842	A	12/1976	Freitag	
4,408,751	A	10/1983	Dodson et al.	
5,064,030	A	11/1991	Wossner	
5,106,065	A *	4/1992	Staton	F16F 9/0209 188/269
5,722,642	A *	3/1998	Bradshaw	A47C 11/00 256/1
5,735,371	A	4/1998	Jobelius et al.	
6,959,921	B2 *	11/2005	Rose	F16F 9/526 188/300
7,484,720	B2	2/2009	Lange et al.	

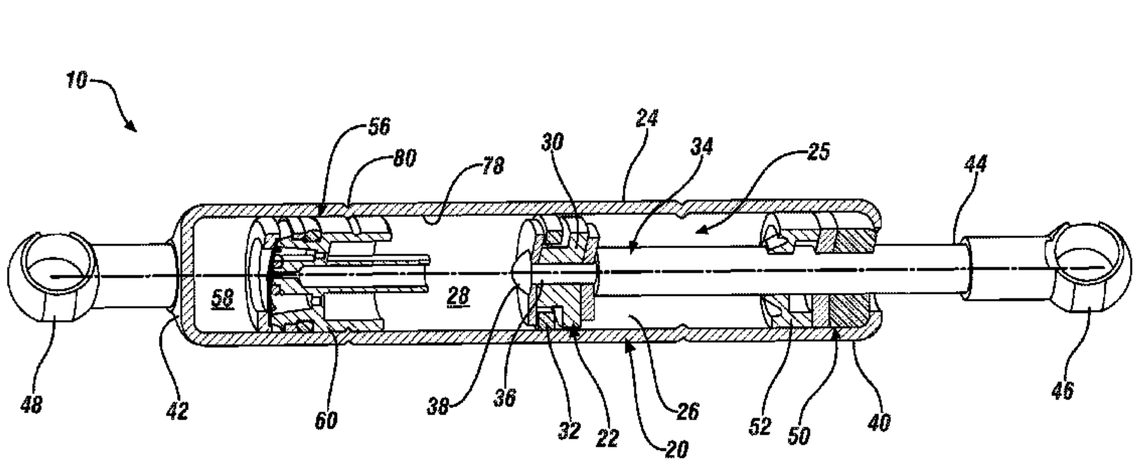
* cited by examiner

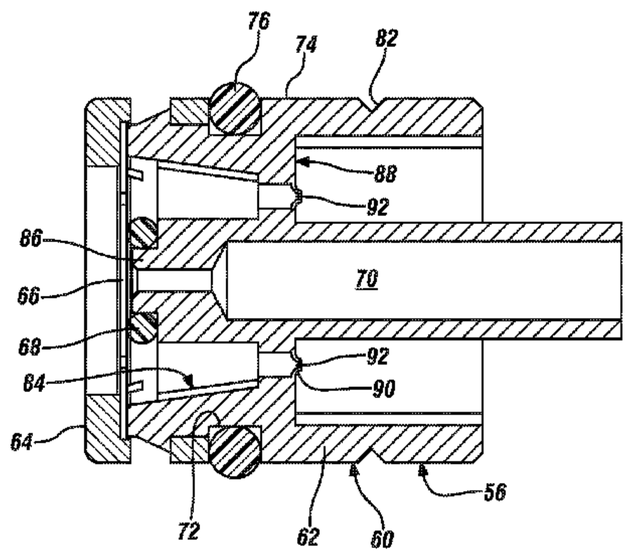
Primary Examiner — Christopher Schwartz
(74) *Attorney, Agent, or Firm* — Cantor Colburn LLP

(57) **ABSTRACT**

A pneumatic spring strut assembly comprises a cylinder wall defining an interior volume having a working end and a boosting chamber adjacent to the working end, the working end including a first volume of gas and the boosting chamber including a second volume of gas, a piston assembly disposed for reciprocation in the working end of the interior volume, a piston rod having a proximal end secured to the piston and a distal end projecting out of the interior volume, a temperature control valve assembly disposed in the interior volume separating the working end from the boosting chamber and including an engineered portion that is configured to prevent fluid flow between the working end and the boosting chamber while the first volume of gas is present in the working end and to permit fluid flow between the working end and the boosting chamber should the working end be evacuated of the first volume of gas.

16 Claims, 3 Drawing Sheets





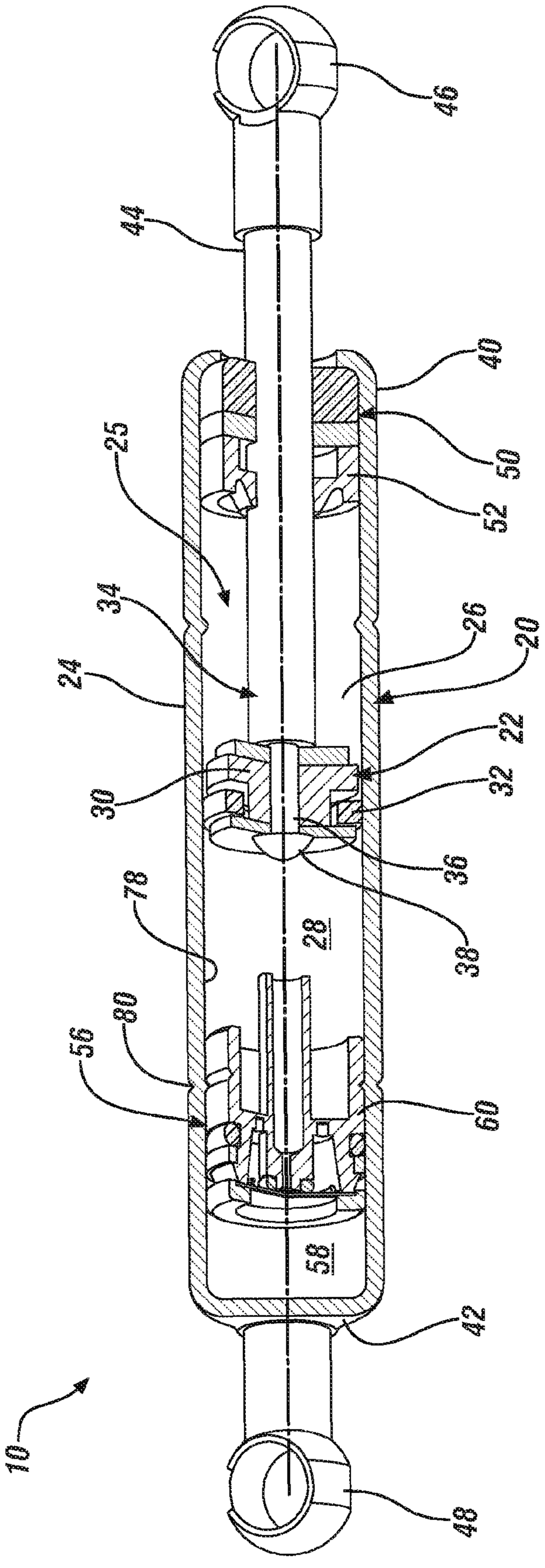


FIG. 1

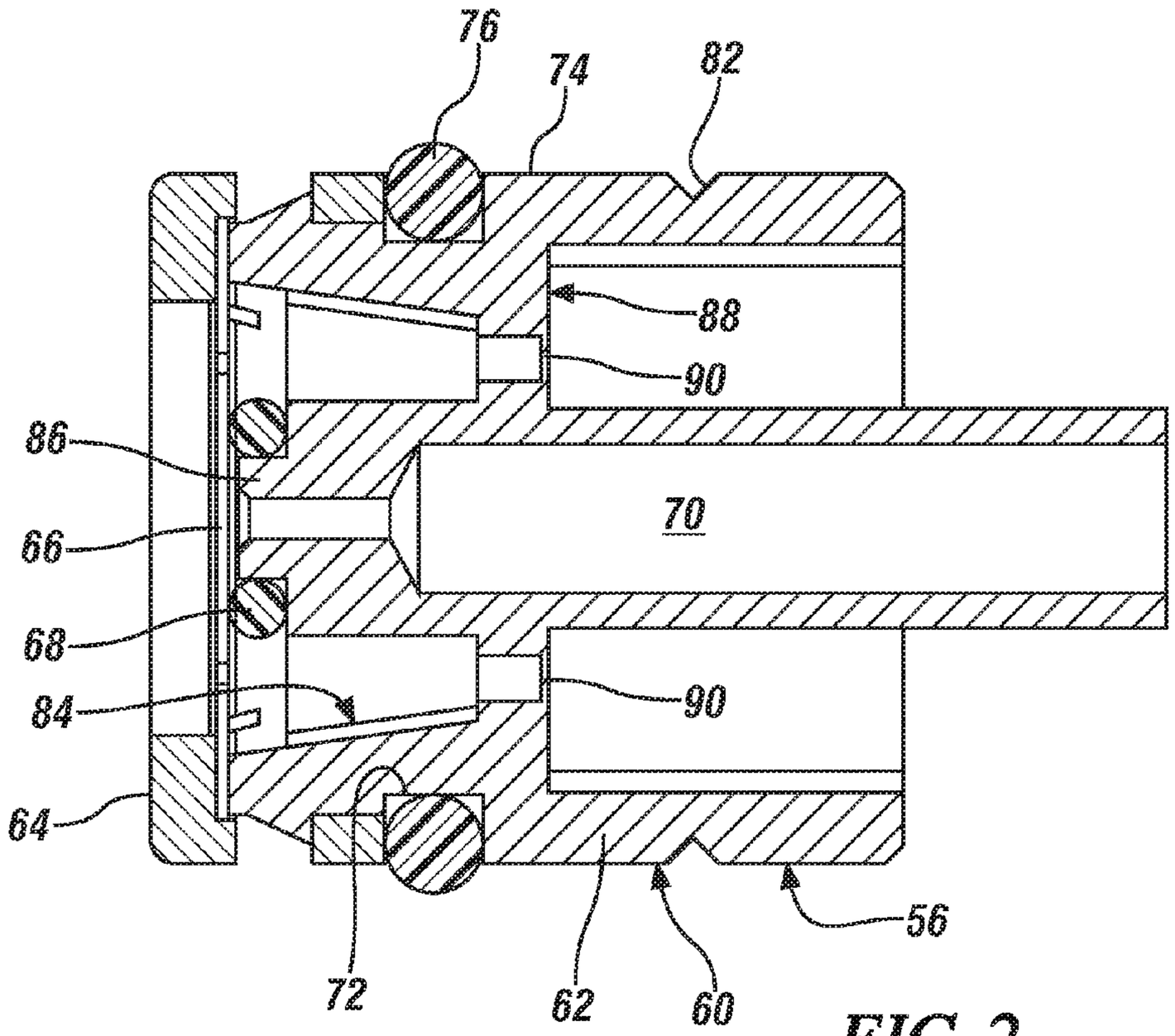

76
74
82
88
90
86
70
66
68
84
90
64
72
62
60
56

FIG. 2

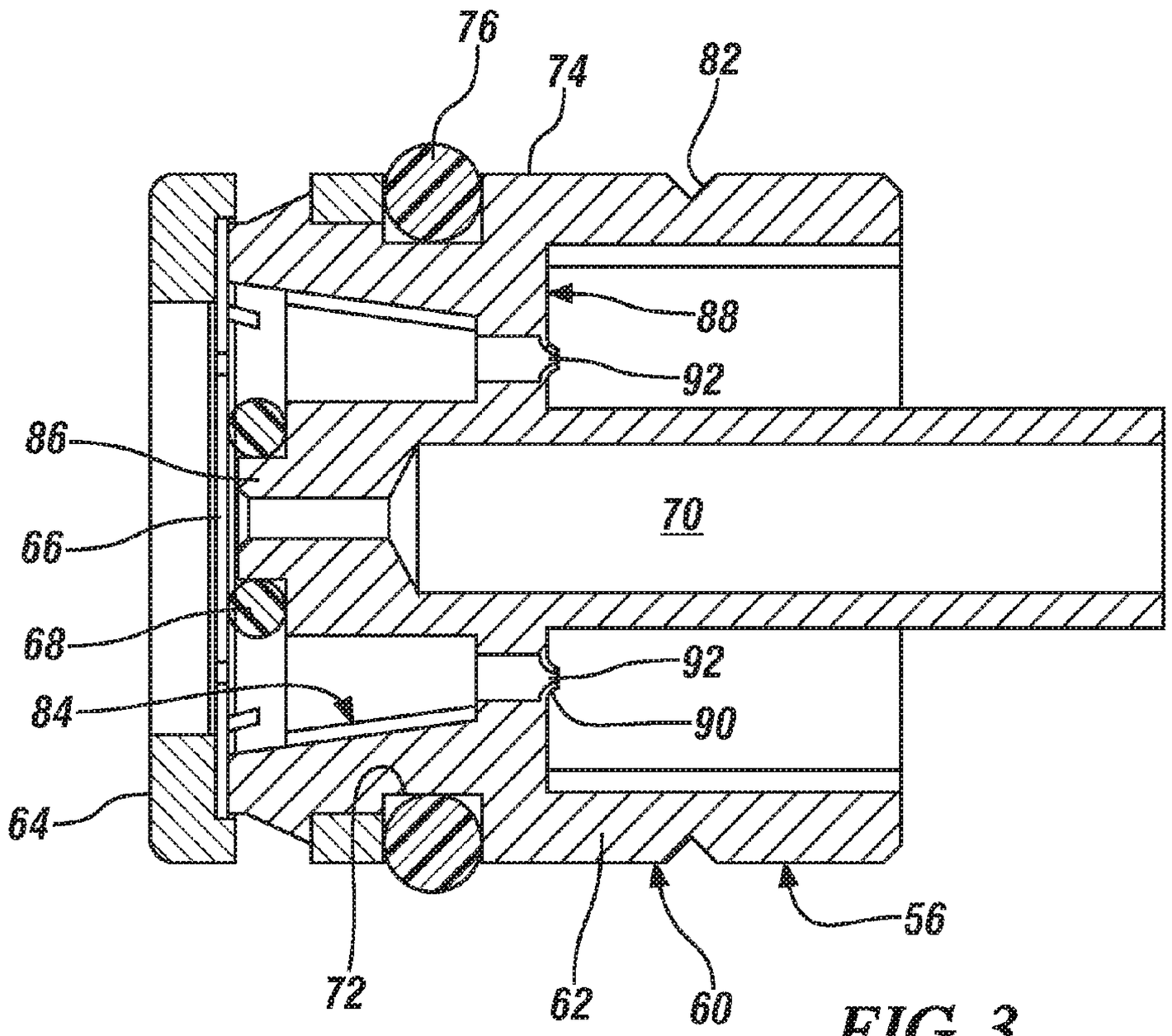
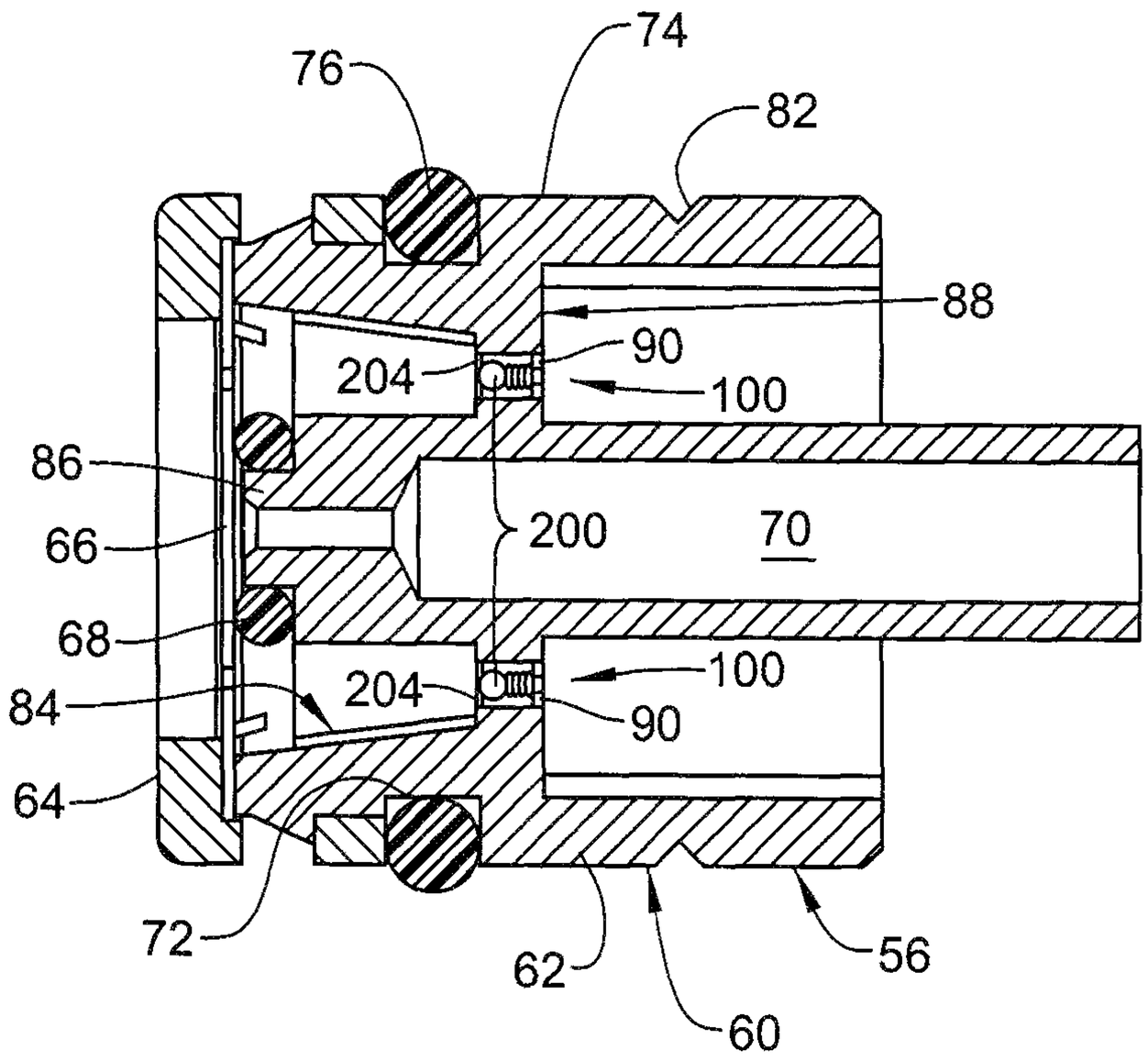

76
74
82
88
92
86
70
66
68
92
84
90
64
72
62
60
56

FIG. 3

FIG. 4



PRESSURE VALVE FOR GAS SPRING

FIELD OF THE INVENTION

The subject of the invention is related to multi-chamber, temperature compensated pneumatic spring struts and, more particularly, to a temperature compensating valve assembly having over-temperature compensation.

BACKGROUND

Pneumatic spring struts (gas springs) are widely used to either partly or totally counterbalance engine compartment hoods, trunk lids, rear windows and tailgates of vehicles to facilitate opening them and to hold them open. The force outputs of gas springs may vary considerably with ambient temperature swings. That is, at low ambient temperatures the gas spring produces a force that can be significantly lower than the force produced at higher ambient temperatures. To offset this effect a temperature compensating valve (TCV) assembly is assembled into pneumatic spring strut bodies. The TCV assembly separates the gas chamber of the gas spring into two separate pressure chambers. When the valve is closed, for example at temperatures above 4 degrees C., the gas spring functions only using a main pressure chamber. At cold ambient temperatures, for example at temperatures below 4 degrees C., the valve opens, allowing the gas spring to operate and provide an output, or lift force, based on the volume of gas in the main pressure chamber and an additional volume. The additional volume is contained in a secondary pressure chamber.

In some cases, such as following damage to the vehicle following a crash, gas in the main pressure chamber may escape from the pneumatic spring strut due to leakage around the lift rod seal. In cases in which the pneumatic spring strut temperatures are elevated it is desirable to release the gas pressure in the secondary pressure chamber to prevent it from dislodging the TCV assembly from its seated position in the pneumatic spring strut body.

SUMMARY

In an exemplary embodiment a pneumatic spring strut assembly comprises a cylinder wall defining and interior volume having a working end and a boosting chamber adjacent to the working end, the working end including a first volume of gas and the boosting chamber including a second volume of gas, a piston assembly disposed for reciprocation in the working end of the interior volume, a piston rod having a proximal end secured to the piston and a distal end projecting out of the interior volume, a temperature control valve assembly disposed in the interior volume separating the working end from the boosting chamber and including an engineered portion that is configured to prevent fluid flow between the working end and the boosting chamber while the first volume of gas is present in the working end and to permit fluid flow between the working end and the boosting chamber should the working end be evacuated of the first volume of gas.

In another exemplary embodiment a pneumatic spring strut assembly for a vehicle lift-gate comprises a cylinder and a piston assembly disposed in the cylinder for reciprocation in a working end. The piston has a piston rod secured at one end to the piston and projecting out of the cylinder at a second end. A temperature control valve assembly separates the working end of the cylinder from an adjacent boosting chamber and comprises a partition wall bushing unit fixed inside of the cylinder to define the boosting chamber and the working end and includes a body, a cap, a wall and an engineered portion that is configured to maintain integrity while pressurized gas is present in the working end and the boosting chamber and to allow fluid flow between the boosting chamber and the working end should the working end be evacuated of pressurized gas.

In yet another embodiment, a pneumatic spring strut assembly for a vehicle panel comprises a cylinder wall defining and interior volume having a working end and a boosting chamber adjacent to the working end, the working end including a first volume of gas and the boosting chamber including a second volume of gas, a piston assembly disposed for reciprocation in the working end of the interior volume, a piston rod having a proximal end secured to the piston and a distal end projecting out of the interior volume, a temperature control valve assembly disposed in the interior volume separating the working end from the boosting chamber and including an engineered portion that is configured to prevent fluid flow between the working end and the boosting chamber while the first volume of gas is present in the working end and to permit fluid flow between the working end and the boosting chamber should the working end be evacuated of the first volume of gas.

The above features and advantages, and other features and advantages of the invention, are readily apparent from the following detailed description of the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features, advantages and details appear, by way of example only, in the following detailed description of embodiments, the detailed description referring to the drawings in which:

FIG. **1** is a sectional, plan view of a pneumatic spring strut embodying features of the invention;

FIG. **2** is a sectional view of a temperature compensating valve assembly embodying features of the invention;

FIG. **3** is another embodiment of a temperature compensating valve assembly embodying features of the invention; and

FIG. **4** is yet another embodiment of a temperature compensating valve assembly embodying features of the invention.

DESCRIPTION OF THE EMBODIMENTS

The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features. As used herein, the term vehicle is not limited to just an automobile, truck, van or sport utility vehicle, but includes any self-propelled or towed conveyance suitable for transporting a burden. The embodiments shown are applicable to vehicle components, but the system disclosed herein may be used in any suitable applications in which a pneumatic spring strut has application (ex. transportation, energy and aerospace applications, home appliance, home and particularly including many other types of vehicular components and applications).

Referring now to FIG. **1** in an exemplary embodiment, a pneumatic spring strut assembly **10**, for use in assisting with opening and maintaining open a vehicle panel, has a cylinder **20** having a cylinder wall **78** defining an interior volume **25** and whose length is determined by the type of equipment

with which the spring strut assembly **10** is to be used. A piston assembly **22** is disposed in the cylinder **20** for reciprocation at a first working end **24**. The first working end **24** is separated by the piston assembly **22** into two compartments **26** and **28** which are filled with a first volume of gas (e.g., air, nitrogen or some other inert gas) under pressure. The piston assembly **22** may include a free-fitting piston **30**, a piston ring **32** and a piston rod or shaft **34** secured at a first, proximal end **36** to the piston by swaging over or riveting at **38**.

The piston shaft **34** projects out through a first end **40** of cylinder **20**; the second end **42** of which is closed. The second, distal end **44** of shaft **34** has a connector link **46** rigidly secured thereto and a second connector link **48** is fixed to the second end **42** of the cylinder **20**. Within the cylinder **20** the piston shaft **34** passes through a large seal **50** and guide package **52**. The first end **40** of the cylinder **20** is crimped about the seal **50** and guide package and internal gas pressure helps to maintain the seal in position.

The concept of temperature compensation involves using a temperature control valve "TCV" assembly **56** to separate the first, working end **24** of the cylinder **20** within which the piston reciprocates, from an adjacent boosting chamber **58** containing a second volume of gas under pressure. Referring now to FIG. **2**, with continuing reference to FIG. **1**, the TCV assembly **56** comprises a partition wall bushing unit **60** which is fixed in a predetermined location inside of the cylinder **20** to define the aforementioned boosting chamber **58**. The partition wall bushing unit, or bushing valve **60**, may be constructed as shown in FIG. **2** and comprises a body **62** and a cap **64**. A valve member such as a bimetallic spring member **66** is retained between the body **62** and the cap **64**. An O-ring **68** is located below the bimetallic spring member **66** and seals the bimetallic spring when the TCV assembly **56** is in the closed position against a valve seat **86**, as shown in FIG. **2**. In the open position (not shown), the bimetallic spring member **66** bends away from, and disengages from the O-ring **68** and valve seat **86** providing an opening to the hollow tube portion **70** which leads to compartment **28** of the working end **24** of the cylinder **20**. When ambient temperatures decrease, for example below 4 degrees C., the bimetallic spring member **66** curves away from and disengages from the O-ring **68** and valve seat **86** in the open position (not shown).

The TCV assembly **56** is assembled into the cylinder **20**. As shown in FIG. **2**, the body **62** comprises a seat **72** extending about the circumference of an outer wall **74** in which a second O-ring **76** is located. The second O-ring forms a seal with the cylinder wall **78** of the cylinder **20**. The cylinder **20** may have a tube groove **80** formed therein, typically following the insertion of the TCV assembly into the cylinder. The tube groove **80** interfaces with a circumferentially extending retention notch **82** in the outer wall **74** and operates to maintain the TCV assembly **56** in place in the cylinder **20** and to form an additional seal with the cylinder wall **78** of the cylinder **20**. In another embodiment (not shown) the TCV assembly **56** may be press fit into the cylinder **20**.

In an embodiment, an annular recess **84** surrounds the valve seat **86** upon which the bimetallic spring member **66** is operably positioned. A wall **88** separates the boosting chamber **58** from the working end **24** of the cylinder **20**. An engineered portion **90** is disposed in the wall **88** and has a thickness that is configured to maintain integrity during normal operation of the pneumatic spring strut assembly **10**. As such, while pressurized gas is present on both sides of wall **88** in compartment **28** and boosting chamber **58** fluid flow of pressurized gas between the first working end **24** and the boosting chamber **58** is prevented. However, should compartment **28** be evacuated of pressurized gas due to a leakage of seal **50** or other leakage event, the engineered portion **90** will yield, or open, (FIG. **3**) to release the gas pressure in the boosting chamber **58** thereby avoiding a pressure differential across the partition wall bushing unit **60** that could result in its dislodging from a seated position. By yielding, the engineered portion **90** defines an aperture **92** in the partition wall bushing unit **60** which will permit the fluid flow between the first working end **24** and the boosting chamber **58** to thereby facilitate the harmless escape of the compressed gas from boosting chamber **58**.

The pressure differential at which the engineered portion **90** yields, or opens, may be selected to range from the differential between the two chambers **26**, **58** at the time of evacuation up to the differential prior to that which is required to dislodge the partition wall bushing unit **60** from its seated position within cylinder **20**. The engineered portion **90** may be cast into the partition wall bushing unit **60** or machined-in following casting. In addition, while the partition wall bushing unit **60** is shown with an annular recess **84** surrounding the valve seat **86**, such a feature is not necessarily required for proper operation of the engineered portion **90** which may be disposed in a thicker portion of the unit with no reduction in effectiveness. Additionally, while the engineered portion **90** has been illustrated herein as comprising a type of burst wall, a biased check valve **100** such as a spring loaded ball bearing **200** in a valve seat **202** machined in the wall **88** is also contemplated as falling within the scope of the invention.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation of material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the application.

What is claimed is:

1. A pneumatic spring strut assembly comprising:

a cylinder wall defining and interior volume having a working end and a boosting chamber adjacent to the working end, the working end including a first volume of gas and the boosting chamber including a second volume of gas;

a piston assembly disposed for reciprocation in the working end of the interior volume, a piston rod having a proximal end secured to the piston assembly and a distal end projecting out of the interior volume; and

a temperature control valve (TCV) assembly disposed in the interior volume separating the working end from the boosting chamber, the TCV assembly including a valve member responsive to changes in temperature to selectively fluidically connect the working end and the boosting chamber, and an engineered portion that is configured to prevent fluid flow between the working end and the boosting chamber while the first volume of gas is present in the working end and to yield permitting fluid flow from the boosting chamber to the working end should the working end be evacuated of the first volume of gas.

2. The pneumatic spring strut assembly of claim 1, wherein a wall in the temperature control valve assembly separates the boosting chamber the working end.

3. The pneumatic spring strut assembly of claim 2, wherein the engineered portion is disposed in the wall and comprises a portion of reduced thickness.

4. The pneumatic spring strut assembly of claim 3, wherein by yielding, the engineered portion defines an aperture in the wall which permits the escape of the second volume of gas from the boosting chamber.

5. The pneumatic spring strut assembly of claim 3, wherein the engineered portion may be cast into the wall or machined-in following casting.

6. A pneumatic spring strut assembly for a vehicle panel comprising:

a cylinder;

a piston assembly disposed in the cylinder for reciprocation in a working end, the piston assembly having a piston rod secured at one end to the piston assembly and projecting out of the cylinder at a second end; and

a temperature control valve assembly separating the working end of the cylinder from an adjacent boosting chamber, the temperature control valve assembly comprising:

a valve member responsive to changes in temperature to selectively fluidically connect the working end and the boosting chamber; and

a partition wall bushing unit fixed inside of the cylinder to define the boosting chamber and the working end and comprising a body, a cap, a wall and an engineered portion that is configured to maintain integrity while pressurized gas is present in the working end and the boosting chamber and to yield allowing fluid flow from the boosting chamber to the working end should the working end be evacuated of pressurized gas.

7. The pneumatic spring strut assembly of claim 6, wherein the engineered portion is disposed in the wall and comprises a portion of reduced thickness.

8. The pneumatic spring strut assembly of claim 6, wherein by yielding, the engineered portion defines an aperture in the wall which permits the escape of the pressurized gas from the boosting chamber.

9. The pneumatic spring strut assembly of claim 6, wherein the engineered portion may be cast into the partition wall bushing unit or machined-in following casting.

10. A pneumatic spring strut assembly for a vehicle panel comprising:

a cylinder wall defining an interior volume having a working end and a boosting chamber adjacent to the working end, the working end including a first volume of gas and the boosting chamber including a second volume of gas;

a piston assembly disposed for reciprocation in the working end of the interior volume, a piston rod having a proximal end secured to the piston and a distal end projecting out of the interior volume; and

a temperature control valve (TCV) assembly disposed in the interior volume separating the working end from the boosting chamber, the TCV assembly including a valve member responsive to changes in temperature to selectively fluidically connect the working end and the boosting chamber, and an engineered portion that is configured to prevent fluid flow between the working end and the boosting chamber while the first volume of gas is present in the working end and to yield permitting fluid flow from the boosting chamber to the working end should the working end be evacuated of the first volume of gas.

11. The pneumatic spring strut assembly of claim 10, wherein a wall in the temperature control valve assembly separates the boosting chamber the working end.

12. The pneumatic spring strut assembly of claim 11, wherein the engineered portion is disposed in the wall and comprises a portion of reduced thickness.

13. The pneumatic spring strut assembly of claim 12, wherein by yielding, the engineered portion defines an aperture in the wall which permits the escape of the second volume of gas from the boosting chamber.

14. The pneumatic spring strut assembly of claim 12, wherein the engineered portion may be cast into the wall or machined-in following casting.

15. The pneumatic spring strut assembly of claim 10, the engineered portion comprising a biased check valve.

16. The pneumatic spring strut assembly of claim 15, the biased check valve comprising a spring loaded ball bearing in a valve seat machined in the temperature control valve.

* * * * *